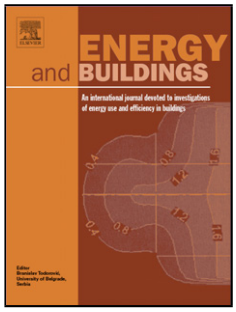

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Transient flows in displacement ventilation enhanced by solar chimney and fan

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Abstract

Theoretical analysis was carried out to develop an unsteady-state model for displacement ventilation in buildings with solar chimneys and fans. The influence of solar radiation intensity and the height of the solar chimney on the interface height, reduced gravity and natural ventilation rate was analyzed, as well as the mechanical ventilation rate and the area ratio of the openings. It was found that the interface height and airflow rate increased significantly with solar radiation intensity and the height of the solar chimney for a relatively smaller time scale ratio, but reduced gravity increased significantly for a larger time scale ratio. When the mechanical force assisted the thermal force, the increasing mechanical ventilation rate and area ratio increased the interface height and total ventilation rate, but decreased the natural ventilation rate in hybrid ventilation.

Keywords: displacement ventilation, solar chimney, fan, thermal stratification

1. Introduction

Since the mid-1970's much attention has been paid to improve the energy-savings in buildings. Using natural ventilation is an effective method for reducing the energy consumption of a building, but natural ventilation depends on climate and has many disadvantages, such as poor thermal control and variable ventilation. In order to enhance the ventilation rate in buildings, solar chimneys and mechanical ventilation are often applied to assist natural ventilation. The experimental results obtained by Afonso and Oliveira [1] showed that there was a significant increase in the ventilation rate with solar chimneys. Some experiments and theoretical investigations were carried out to study the effects of geometry, inclination angle and meteorological parameters on the ventilation performance of solar chimneys[2~4].

The air flow in displacement ventilation enhanced by solar chimneys and fans varies, as the heating load and solar radiation change during the day. This causes the variation in air flow rate and time-varying flows. It is very useful to study the dynamic behavior of global variables (indoor temperature, interface height and air